Proceedings of the Iowa Academy of Science

Volume 25 | Annual Issue Article 32

1918

Notes on the Floristic Features of a Prairie Province in Central Iowa

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NOTES ON THE FLORISTIC FEATURES OF A PRAIRIE PROVINCE IN CENTRAL IOWA.

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The primeval prairie of Iowa is fast vanishing. This region where grass grew tall and prairie fires yearly swept over expanses bounded by the horizon or broken here and there by zones of forest along the streams, man, one of the most important of ecological forces, has selected for his permanent habitat. The prairie of former years now lingers in small patches bounded by wire fences and known as hay fields; or where the less ambitious farmer has failed to insert an arterial system of tile, occasional sloughs and swamps furnish homes for hosts of sturdy cat-tails, slim reeds, plumy grasses and their associates growing with all the glory of former generations. Several of these reserved prairie patches within a radius of a mile show representative growth including a range of characteristic species considerable for such an area. The gradual changes through a period of thirty years have been noted by one observer but only in the last ten years have specific notes been made.

Analyses of the soil, seasonal temperature, weather records, topographic and geologic features have been reported in Ecologic Topographic Notes on a Prairie Province in Central Iowa. Anatomic characters of some of these plants are discussed in Anatomic-Ecologic Notes on Some Plants of a Prairie Province.

ANALYSIS OF THE FORMATIONS OF THE PRAIRIE PROVINCES.

In this survey the intention is to state observations unadorned by nomenclature. Such terms as are used conform to Clement's system as stated in Research Methods in Ecology.

Schimper, Clements and Warming summarize the more important literature on the subject of ecological nomenclature. These writers do not agree in regard to the use of ecological terms. According to Farlow's report, the Brussels Congress of 1910 recommended the use of the terms "formation" in the broader and "association" in the restricted sense. This limitation of the term formation is, however, not defined. Clements claims that it should be synonymous with the term habitat while Schimper uses it with such a broad range of meaning as to embrace a prairie province or a forest province. Despite the differences in the limitation of the region embraced, the salient

features in the conception of the formation are, as described by Warming, an expression of certain well defined conditions of life and are not concerned with floristic differences. On this basis the Prairie Province under inspection may be divided into the following regions with reference to:

A—Topography
- I Upland
  - Hilltop
  - Slope
  - Meadow
- II Lowland
  - Meadow
  - Swamp
  - Ponds

B—Formations
- I Upland prairie
- II Meadow
- III Swamp
- IV Pond

Stipa-Bouteloua Formation.
Soil gravelly, sandy loam or loam.
Arrangement: copious.
The main consocies as represented by more prominent species are:

A. Consocies—*Bouteloua.*
Location: Hilltop, gravelly loam.
The principal species are:
Bouteloua curtipendula, Bouteloua hirsuta, Koeleria cristata, Carex pennsylvanica, Astragalus caryocarpus, Comandra umbellata, Anemone cylindrica, Anemone patens var. *Wolfgangiana, Agoseris cuspidata, Oenothera serrulata, Solidago speciosa, Liatris cylindrica, Euphorbia corollata, Lithospermum canescens, Lithospermum angustifolium, Petalostemum purpureum, Polygala verticillata.*

The societies of the seasonal aspects are:

(1) Spring aspect.
Anemone patens var. *Wolfgangiana, Comandra umbellata, Agoseris cuspidata.*

(2) Summer aspect.
Bouteloua curtipendula, Bouteloua hirsuta, Koeleria cristata, Polygala verticillata.

(3) Fall aspect.
Bouteloua hirsuta, Bouteloua curtipendula, Andropogon furcatus, Liatris cylindrica, Aster azureus, Solidago speciosa.

B. Consocies *Stipa.*

Location: Slope or level prairie (Heuchera Hill type or upland level of Grove's Field).

Soil: loam to sandy loam.

Arrangement: Copious or slightly copious, gregarious.

The main species are:

Brauneria purpurea, Psoralea argophylla, Stipa spartea, Sporobolus, Coreopsis palmata, Liatris pycnostachya, Liatris squarrosa, Lespedeza capitata, Delphinium Penardi, Lilium

Fig. 145.—Kame Hill, Alluvial basin below, probably the pre-Wisconsin bed of Des Moines river.

philadelphicum, Phlox pilosa, Heuchera Americana, Pedicularis canadensis, Viola pedata, Baptisia bracteata, Eryngium yuccaefolium, Amorpha canescens, Gentiana puberula, Solidago speciosa, Solidago rigida, Petalostemum purpureum, Sisyrinchium angustifolium, Hypoxis hirsuta, Aster sericeus, Aster multiflorus.

Societies:

(1) Spring aspect:

Viola pedata, Pedicularis canadensis, Phlox pilosa, Baptisia bracteata, Sisyrinchium angustifolium.

(2) Summer aspect:

Brauneria purpurea, Lilium philadelphicum, Amorpha canescens, Heuchera Americana, Psoralea argophylla, Eryngium yuccaefolium, Desmodium illinoense, Lespedeza capitata, Lespedeza leptostachya.

(3) Fall aspect:

Aster multiflorus, Liatris pycnostachya, Liatris squarrosa, Gentiana puberula, Aster azureus, Aster sericeus.

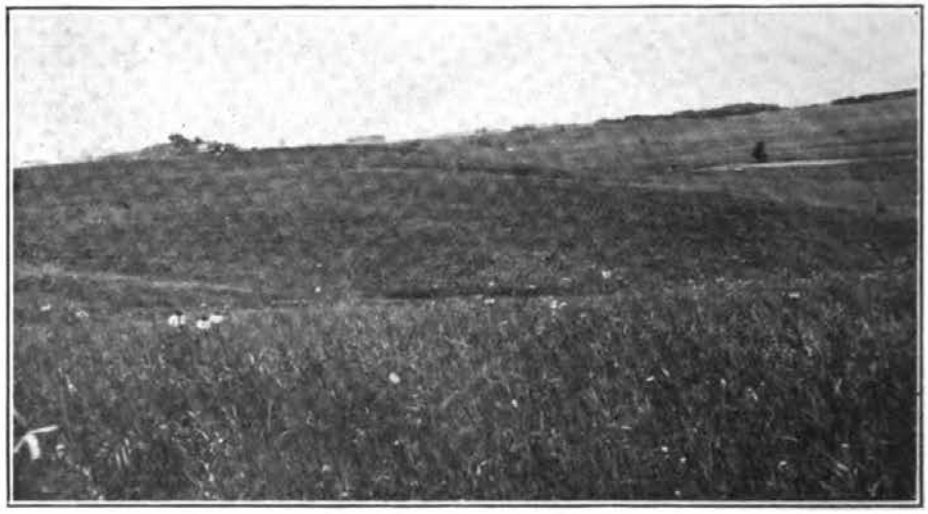

Fig. 146.—Anemone patens Hill. West end of Alluvial Basin to the right.

The amount of rainfall and seasonal low or high temperature retards or hastens the time of appearance as well as affects the abundance and stature of most of these species. *Lilium philadelphicum* (consoc. II) shows marked reaction to seasonal conditions.

Variation in soil within small areas causes alteration in consocies, eliminating certain members; for example, the gravelly top of the *Anemone patens* hill, and the two lobes of the Heuchera hill have similar consocies. On the crest of Heuchera hill is a small knoll, more gravelly and drier than the immediately surrounding region. Here the species are sparsely arranged and some are eliminated, *Bouteloua hirsuta* and *Oenothera serrulata* being the principal survivors of this condition. The northeast [illegible] practically identical in physical struc-

Fig. 147.—Kame Hill region—upland prairie. Heuchera Hill type. Lilium canadense. Brauneria purpurea.

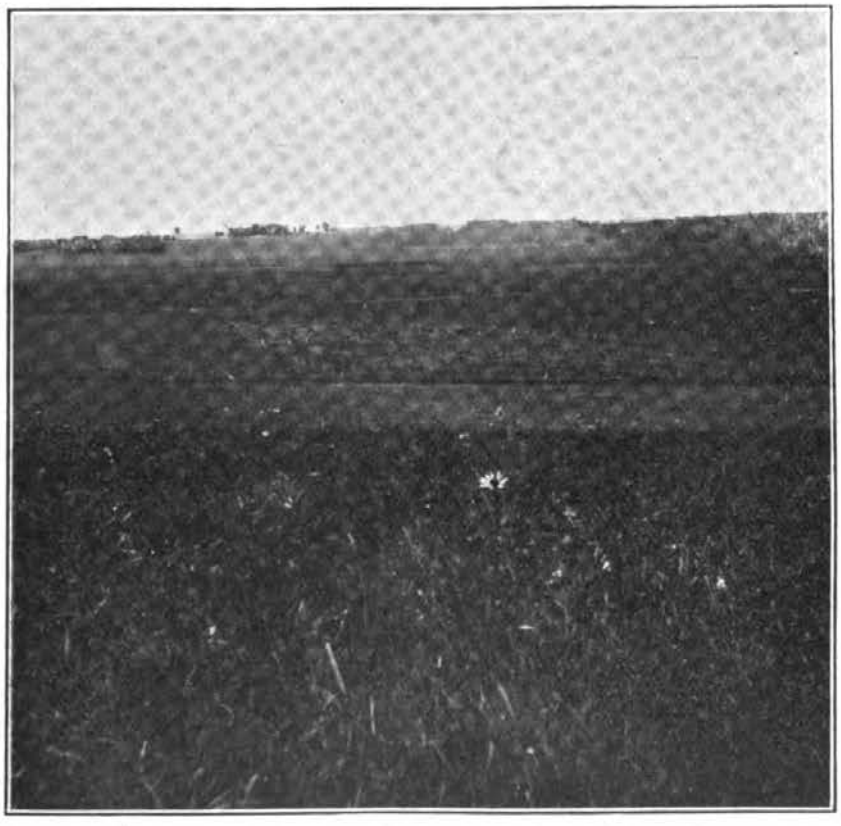

Fig. 148.—Fenced Prairie surrounded by pasture in Alluvial Basin. Swamp in distance. Heuchera Hill, foreground. Brauneria purpurea.

ture. *Anemone patens* var. *Wolfgangiana* has grown abundantly for years on one of them while on the other two hills in a corresponding location one thriving plant is present on one hillside and six or seven plants on the other hill, but the plants do not increase in number.

REVERSION.

Adjacent to the Anemone patens hill are two strips of prairie, one of which has been uncultivated for twenty-one years and the other uncultivated for thirty-six years. The following lists show the constituent plants of these associations.

Fig. 149.—Alluvial Basin looking northeast from Heuchera Hill. Braunaria purpurea.

UNCULTIVATED PRAIRIE.

The species found in this area are:

Andropogon furcatus, Andropogon scoparius, Bouteloua curtipendula, Bouteloua hirsuta, Elymus robustus, Koeleria cristata, Sorgastrum nutans, Stipa spartea, Comandra umbellata, Anemone patens var. *Wolfgangiana, Rosa pratincola, Amorpha canescens, Petalostemon candidum, Petalostemum purpureum, Lithospermum canescens, Lithospermum angustifolium, Artemisia ludoviciana, Aster azureus, Aster sericeus, Chrysopsis villosa, Coreopsis palmata, Heliopsis scabra, Sil-*

phium laciniatum, Solidago missouriensis, Solidago speciosa, Solidago rigida.

AREA TWENTY-ONE YEARS UNCULTIVATED.

The species included here are:

Equisetum laevigatum var. *robustum, Agrostis alba, Andropogon scoparius, Panicum Scribnerianum, Poa pratensis, Anemone cylindrica, Potentilla arguta, Rosa pratincola, Lespedeza capitata, Linum sulcatum, Euphorbia corollata, Oenothera biennis, Convolvulus sepium, Verbena hastata, Ambrosia artemisiifolia, Cirsium lanceolatum, Helianthus grosseserratus, Lactuca canadensis, Lepachys pinnata, Liatris squarrosa, Solidago rigida,*

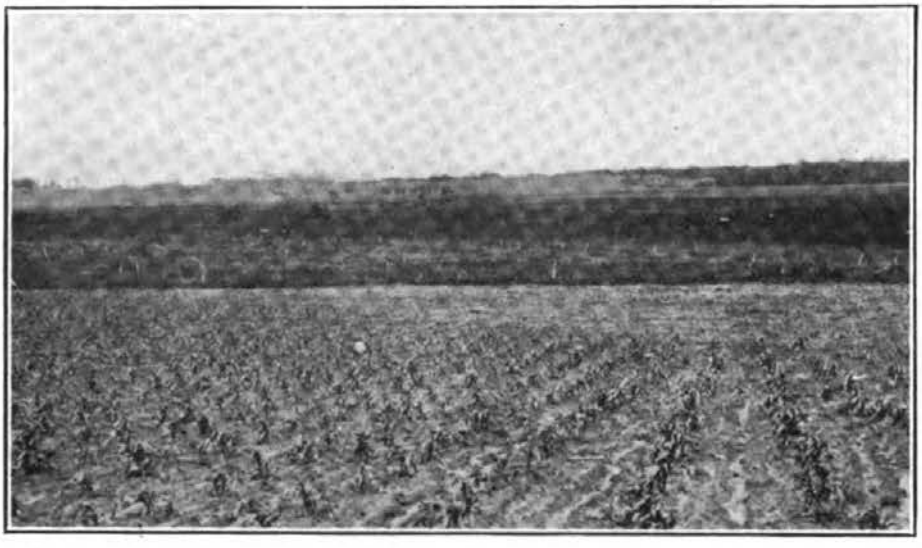

Fig. 150.—East end of Alluvial basin from Heuchera Hill.

Onosmodium molle, Monarda fistulosa, Pycnanthemum virginianum, Physalis lanceolata, Gerardia aspera, Veronica virginica, Aster multiflorus, Cirsium lanceolatum, Heliopsis scabra, Liatris pycnostachya, Eryngium yuccaefolium, Silphium laciniatum, Solidago missouriensis, Solidago speciosa.

AREA THIRTY-SIX YEARS UNCULTIVATED.

The species here found were:

Andropogon scoparius, Bouteloua curtipendula, Elymus robustus, Panicum Scribnerianum, Panicum virgatum, Poa pratensis, Anemone cylindrica, Potentilla arguta, Rosa pratincola, Rubus villosus, Astragalus caryocarpus, Baptisia bracteata, Desmodium illinoense, Lespedeza capitata, Petalostemum candidum, Petalostemum purpureum, Linum sulcatum, Euphorbia

corrollata, Rhus toxicodendron, Oenothera biennis, Oeothera serrulata, Ceanothus americanus, Eryngium yuccaefolium, Asclepias syriaca, Convolvulus sepium.

Plants characteristic of the permanent prairie, such as *Solidago* and *Lespedeza,* were found most frequently near the edge of the uncultivated prairie strip. In the center of the cultivated area in the upturned earth around an animal's den were *Cirsium lanceolatum, Chenopodium album, Helianthus grosseserratus, Xanthium canadense, Monarda fistulosa* and *Lactuca canadensis.* The patch uncultivated for twenty-one years indicated that its flora was undergoing succession changes. It contained almost

Fig. 151.—Fenced patch of prairie. Alluvial basin.

twice as many species as either of the other two areas, including species of both the newer and older associations.

Reversions from ruderal to prairie type after removal of the original prairie plants is relatively rare in this cool, relatively dry, wind swept region as compared with a moister, warmer climate.* This reversion is sometimes seen in the upland in this

*Near Houston, Texas, was observed an abandened rice field located slightly above the level of a cypress swamp and bordered on two sides by forests of *Pinus taeda,* on one by a road and on the other by a pasture. The field was too low for the successful growing of rice, which must be kept wet only a portion of the year and then dried toward harvest time. After no cultivation for six years, this field had acquired the usual aspect of the prairie of that region and was being rapidly invaded by seedling trees of *P. taeda,* many of which were three or four feet high. Such a transition is not uncommon in this warm, moist climate.

In the same vicinity along the San Jacinto river a forest of *Pinus taeda* with large trees was growing on land which had forty years earlier been

vicinity though in the lowland ruderals well adapted to the moist habitat usually completely supplant the original flora.

A nearby plum-elm thicket in an unmowed ravine on the other side of this hill has caused the grass to disappear from the earth and it is replaced by grove plants. Here is a tendency toward preliminary forest formations.

II Meadow or Wet Prairie.

Panicum-Agrostis Formation.

Location: Between highland and marshes, extends up ravines bordering streams.

Soils: Alluvial, sandy to clay loam.

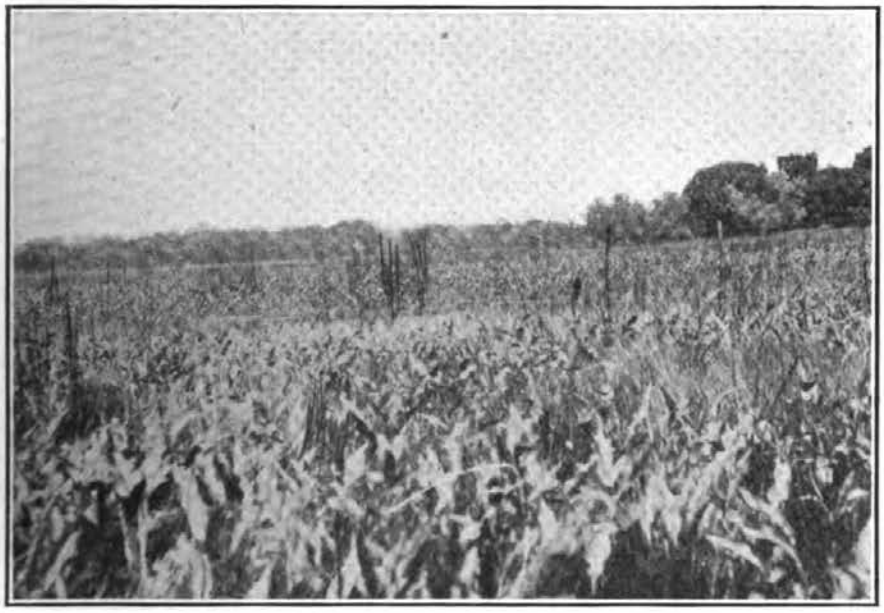

Fig. 152.—Pond in alluvial basin.

Arrangement: Copious, gregarious-copious.

The more important species are:

Andropogon provincialis, Sorgastrum nutans, Panicum Scribnerianum, Panicum virgatum, Agrostis alba, Muhlenbergia racemosa, Spartina cynosuroides, Sium cicutaefolium, Cicuta maculata, Gerardia aspera, Gerardia tenuifolia, Petalostemum purpureum, Petalostemum candidum, Fragaria virginiana var. *illinoense, Erigeron annuus, Rosa pratincola, Senecio aureus, Thalictrum dasycarpum, Anemone canadensis, Phlox maculata, Pedicularis canadensis, Pedicularis lanceolata, Lythrum alatum, Habenaria leucophaea, Steironema ciliatum, Steironema lanceolatum, Steironema quadrifolium, Lippia lanceo-*

lata, Mentha arvensis var. *canadensis, Lycopus americana, Gentiana puberula, Gentiana Andrewsii, Polygala incarnata, Polygala sanguinea, Rudbeckia hirsuta, Lilium canadensis, Helenium antumnale, Lobelia siphilitica, Caltha palustris, Ranunculus septentrionalis, Galium trifidum, Juncus tenuis,*

Fig. 153.—Edge of shallow pond in alluvial basin. Scirpus validus. Tuncus tenuis. Polygonum Muhlenbergii.

Baptisia leucophaea, Viola cucullata, Viola pedatifida, Hyporis hirsuta, Prunella vulgaris, Stachys palustris, Stachys tenuifolia, Teucrium canadense, Pycnanthemum virginianum, Ranunculus septentrionalis, Spiranthes cernua, Aster multiflorus, Solidago

This formation is difficult to separate into consocies though certain grouping has been noted; yet it is not very distinct. The following data will indicate the trend of associations.

A. Consocies *Phlox maculata.*

Location: Near running water or pond.

Soil: Loam to clay loam.

The most representative species are:

Phlox maculata, Caltha palustris, Leersia oryzoides, Agrostis alba, Steironema ciliatus, Steironema quadrifolia, Ranunculus septentrionalis.

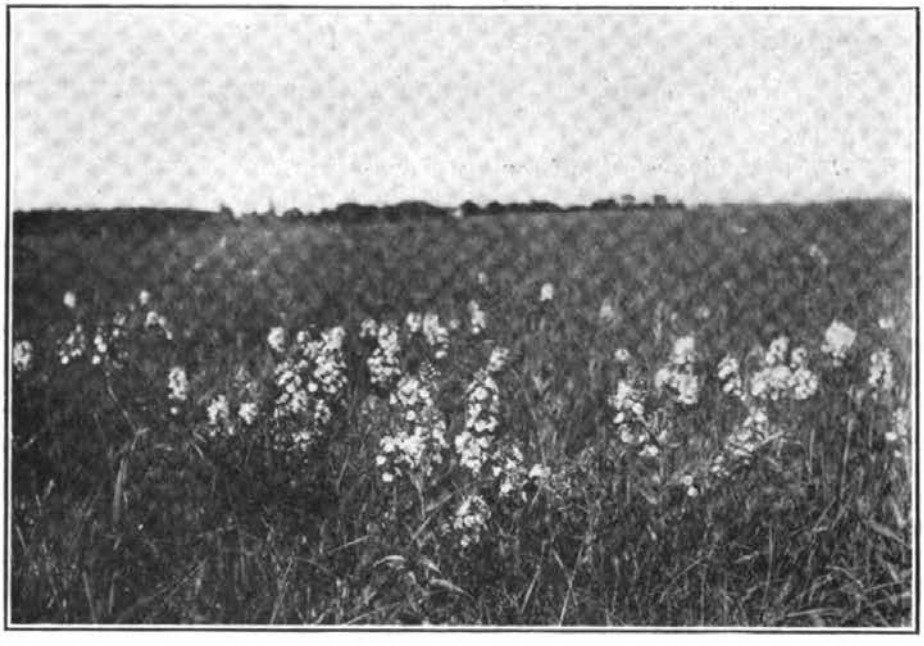

Fig. 154.—Grove's Field. Wet prairie of upland saucer pond region. Phlox maculata.

B. Consocies *Agrostis-Steironema-Lythrum.*

Location: Low, wet, flat land.

The more common species are:

Agrostis alba, Juncus tenuis, Helenium autumnale, Steironema lanceolata, Steironema quadrifolia, Lythrum alatum, Sium cicutaefolium, Anemone canadensis, Mentha arvensis var. *canadensis, Lycopus americana, Pedicularis lanceolata.*

C. Consocies *Panicum-Fragaria-Senecio.*

Location: Damp with better drainings than A or B.

Soil: Loam to clay loam.

Arrangement: Gregarious-copicus.

The representative species are:

Panicum Scribnerianum, Panicum virgatum, Fragaria virginiana var. *illinoensis, Senecio aureus, Anemone canadensis, Viola cucullata, Hypoxis hirsuta.*

D. Consocies *Leersia.*

Location: Wet, low ground.

Soil: Loam to clay loam.

Arrangement: Gregarious.

The prominent species are:

Leersia oryzoides, Anemone canadensis, Physotegia virginiana, Muhlenbergia racemosa, Polygonum Muhlenbergii, Apocynum cannabinum

III. Swamp Location: Standing water present a part of the year.

Typha-Juncus-Penthorum Formation.

Soil: Loam to clay loam.

Arrangement: Aggregate zoned.

A. Consocies *Typha-Juncus.*

The principal species are:

Juncus tenuis, Cyperus sp., *Typha latifolia, Alisma plantago-aquatica, Sagittaria latifolia, Polygonum Muhlenbergii, Leersia oryzoides, Calamagrostis canadensis, Eupatorium, Asclepias purpureum* var. *maculatum.*

B. Consocies: *Penthorum.*

The more common species are:

Penthorum sedoides, Polygonum hydropiper, Polygonum acre, Lippia lanceolata, Steironema lanceolata, Stachys palustris, Epilobium coloratum, Lobelia siphilitica, Bidens cernua.

C. Consocies *Ludwigia-Sparganium.*

The outstanding species are:

Juncus tenuis, Scirpus lacustris, Iris versicolor, Penthorum sedoides, Calamagrostis canadensis, Ludwigia polycarpa, Sparganium eurycarpum.

D. Consocies: *Leersia.*

IV Pond

Ranunculus-Sagittaria Formation. Water present most of the time.

Arrangement: Gregarious, copious, zoned.

A. Consocies *Ranunculus.*

Ranunculus delphinifolius, Alisma plantago-aquatica.

B. Consocies *Sagittaria.*

Sagittaria latifolia, Polygonum amphibii.

The ponds of the saucer-shaped region of Grove's Field are practically identical in physical character, varying somewhat in depth of water, though not exceeding four feet. In some of these ponds, a few species, mostly rare, appear and are not found in other nearby ponds. Only one pond is present in the alluvial basin region. It is of the same type as those in the upland (Grove's Field).

Fig. 155.—East end of alluvial basin. Iris versicolor. Sagittaria latifolia.

INVASION, COMPETITION, AND SUCCESSION.

Forest Invasion of Prairie Along Squaw Creek.

Bordering the narrow strip of timber along Squaw creek narrow tributary ravines cut into the morainal deposit adjacent to the flood-plain. Bordering the forest along the flood-plain are colonies of willow and cottonwood just outside the zones of elm

and oak. Following these ravines a short distance from their mouths are lines of *Crataegus mollis, Pyrus iowensis, Populus deltoides* and *Ulmus fulva.* On the brow of one of these hills are thickets of *Rhus glabra* and young trees of *Ulmus americana,*

Fig. 156.—Anemone patens var. Wolfgangiana. The first and most prominent plant of the spring aspect.

Crataegus mollis, Pyrus iowensis, Vitis vulpina and *Celastrus scandens* are seen. These are typical pioneer wood trees of this region.

The morainal scallops of hills swing around the turn of the river and are wood covered as they run parallel with the river farther on. Next in the series to the *Rhus Ulmus* ravine is an-

other on the sides of which are *Ulmus americana; Gleditschia triacanthos, Salix* and *Rhus glabra,* among which *Poa pratensis* and *Andropogon scoparius* grow. Beginning in the next glen and extending sparsely across the hillside to the established wood are seen *Ulmus americana, Populus deltoides, Fraxinus viridis, Acer negundo, Pyrus iowensis, Gleditschia triacanthos,* one tree of *Quercus macrocarpa,* one of *Q. rubra* and one of *Acer nigrum.* The ground herbage is blue grass, ruderals, *Andropogon scoparius* and *Artemesia ludoviciana,* which illustrates the overlaping of associations. *Fraxinus, Acer* and *Quercus* are final trees of the terminal forest of this region.

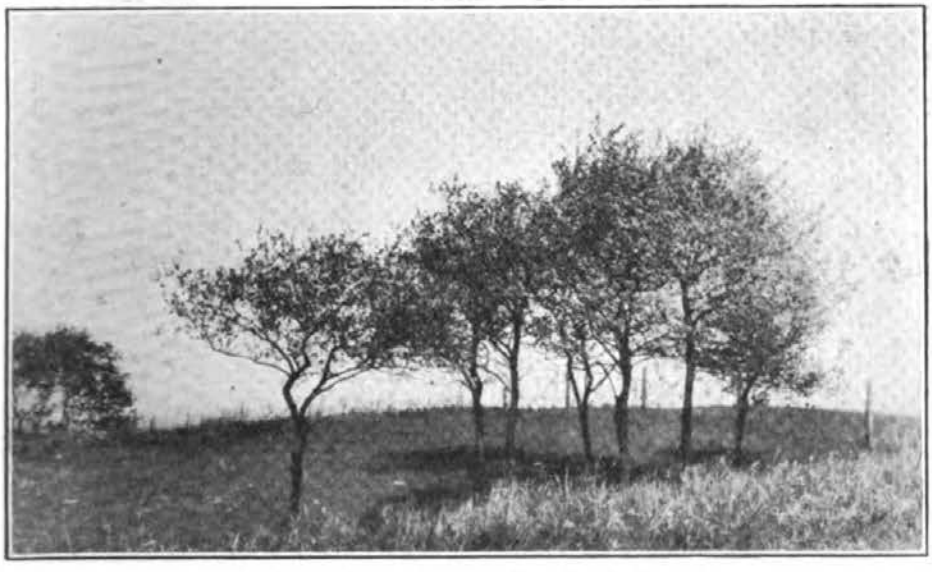

Fig. 157.—Pyrus Iowensis. A tree of the pioneer forest.

These preliminary trees are youngest, most remote from the wood. There are seedlings beneath them. They are seen in the order from the pioneer to the well-known type of the mature forest. There are no stumps or signs of decay in these preliminary clusters. Prairie grasses grow under the first stand of trees which are close enough together to cause much shade. These are in the adjacent established wood replaced by blue grass, wood ruderals and some typical wood plants, among the more conspicuous of which are heart leaved *Viola palmata,* while the dissected leaved *Viola pedatifida* occurs just outside on the prairie on moist slopes and *V. pedata* on slope and ridges. These indications show that forest is here encroaching upon the prairie.

INVASION OF RUDERALS ACCOMPANYING PASTURAGE.

This region has recently been pastured, which condition is affecting the prairie type materially. In the lowland alluvial areas and along the borders of ravines the prairie plants have almost exclusively been driven out by such ruderals as *Ambrosia artemesifolia, Verbena hastata, Polygonum pennsylvanicum, P. persicaria, setaria viridis and Poa pratensis,* though *Baptisia leucantha, Aster novae-angliae, Aster multiflorus* and *Kuhnia* still persist in spots. On the slope *Poa pratensis* is creeping in, giving a marbled appearance where its colonies are supplanting *Aster Drummondi, Solidago rigida, nemorosa, Gentian puber-*

Fig. 158.—Ulmus americana, Populus deltoides and Pyrus Iowensis.—pioneers of the forest advancing up the ravines.

ula, Andropogon scoparius, A. furcatus, Sporobolus cryptandrus, Boutelua curtipendula, B. hirsuta and *Koeleria cristata,* Lichens. *Cnicus Hillii, Liatris, Cacalia tuberosa, Oenothera biennis* and *Astragalus caryocarpus.* These plants have hard, short, thick subterranean stems with intensive root systems occupying small space. They seem to thrive in the hard, gravelly, stony, dry soil of these hill crests where blue grass and other ruderal invaders have not penetrated. The most of the ruderals thrive best with more of moisture and a finer soil than is here found, hence these hill crest types by their tolerance of this habitat can maintain such a formation much longer after invasion processes have commenced than the hillside and alluvial associations can maintain

stability, for the latter are seen to be driven out before the former have begun to give way.

The ability of blue grass to invade formations which for hundreds of years have maintained a balanced type is a phenomenon which has not been satisfactorily explained. It is usually associated with *Verbena stricta* on the hill areas, with *Ambrosia artemesiifolia* throughout its range and quite recently in the vicinity with *Melilotus alba,* which has made its denouement along roadsides and railroads and is continuing its march with blue grass into the prairies. While *Poa pratensis* and *Ambrosia artemesifolia* grow luxuriantly in moderately moist conditions, their

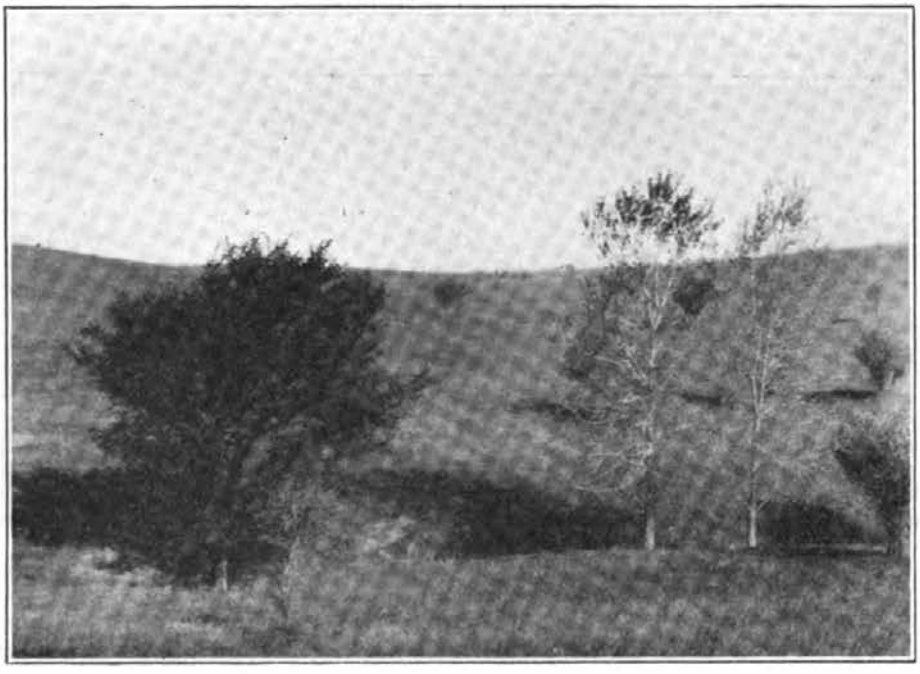

Fig. 159.—Ulmus americana, Populus deltoides, Crataegus mollis,—pioneer forest trees on the edge of a prairie ravine.

range extends from hilltop to alluvial basin though they do not thrive where the soil is constantly saturated nor in stony graveled areas. Blue grass possesses a radially extensive, slender, active rhizome with a fine, close network of node roots which forms a firm sod. Its broad range of habitat combined with its virile rhizome system equips it with unusually good qualities for successful invasion. The fact that Ambrosia though an annual has an abbreviated tap root which fits easily between the roots or rhizomes of other plants while it also has a wide range of

habitat makes it a good invader. *Melilotus alba* has a tough biennial root and fairly wide range of habitat, having a tendency to endure arid conditions. It is rapidly invading a dry gravelly knoll of one of the prairie hills along Squaw creek which is previously described as a stronghold of the intensive rooted *Andropogons, Asters* and *Solidagos.*

Invasion of the Alluvial Basin Meadow.

This blue grass—sweet clover type of invasion has taken place in the last five years in the alluvial basin region below Heuchera hill (See Lists) and in the vicinity there has been a rapid disappearance of the majority of the original plants, yet a few representatives of the original formation remain, among which are

Fig. 160.—Forest bordering Squaw creek advancing toward the prairie.

Panicum virgatum, Senecio aureum, Fragaria virginiana, Sium cicutaefolium, Cicuta maculata, Veronica virginica, Lobelia spicata. No decrease is noted in the number of plants of *Baptisia leucantha.* This plant has a long, tough, thick, deep branched root which is a good reinforcing character. It stands above the surrounding plants and thus has light advantages.

The pond adjacent to the wet meadow area lies also in the pasture but has apparently not been affected. No species have disappeared.

The swamp, though cut late in the year for hay, shows no change in its constituent species except that a willow thicket has grown up along a ditch beside a fence where the grass is not cut. Willows constantly appear in this wet area but are mowed off yearly.

Cutting does not change the constituent character of the highland plants.

Pasturage introduces ruderal plants but most of these do not affect the associations which approach hydrophytic or xerophytic conditions.

Most ruderal plants flourish in mesophytic conditions so that hydrophytic or xerophytic prairie types seem to have fewer competitors than mesophytes.

Fig. 161.—Zone of wood bordering Squaw creek. Populus deltoides and Salix along the edge. Crataegus mollis and Pyrus iowensis advancing toward the prairie.

SUMMARY.

Geology. This area is underlain by rock of the Carboniferous system and Paleozoic group. The present drift deposit of this area is the Wisconsin of the Pleistocene system and Cenozoic group.

Topography. The territory observed consists of: (1) Alluvial basin probably the pre-Wisconsin bed of Skunk river which may have drained a region now occupied by the head waters of Des Moines river; (2) Morainal deposits between the arm of Skunk river and the bend in Squaw creek near Ames.

Edaphic features. The soil types involved are alluvial, sand, sandy loam, loam, gravelly loam and clay loam.

(a) *Water Content.* It is shown by the graphic data that (1) the lowlands contains a materially higher percentage of water than the uplands. (2) There is greater divergence in the percentage contained by the upland surface, subsurface and subsoil than in these corresponding zones of the lowland. (3) The water table of the lowland is quite constant, showing a gradual dip in the autumn. (4) The subsoil curve of the upland is variable,

showing an increase in the autumn. (5) The surface curve (loam) of the lowlands shows a higher water content than its subsoil (sand).

(b) *Temperature.* Graphic data concerning the temperature of the air (three feet above the earth) and surface soil (6 in.) taken at 3 p. m. and 5 a. m. show that (1) the temperature of the earth lags behind that of the air; (2) the lowland temperatures range slightly below the upland. A series of temperatures taken in the air three feet above the earth during the months of April, May, June, July, August, September, October and November show that the temperature of the air is materially higher than that of the soil; (3) The soil absorbs heat cumulatively and gradually radiates it, the lower layers lagging behind the upper in its absorption but retaining the heat longer.

Plant formations. This prairie province may be said to comprise four formations: (1) Upland Prairie (2) Meadow (3) Swamp (4) Pond. Every formation has a variety of local factors such as water content, soil and light, which give rise to constantly recurring groups or *associations* in the presence of the same conditions. The chief causes of difference in associations are their habitat features which are not common factors. The principal factors which are not common or which vary in marked degree are (1) type of soil and (2) water content of habitat. Structure of soil has a direct bearing on water content. Water content depends on the type of soil, drainage and rainfall.

Reversion takes place slowly and is rare. A denuded soil usually does not survive the activities of certain introduced ruderals such as blue grass.

Succession. Evidence of invasion of the prairie by forest in ravines or on moist slopes is not uncommon though it seems limited in progress and restricted to moist locations.

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